

PRESSURE POINT DETECTORField of the Invention

5 This invention relates to a pressure point detector for detecting a location of a point where a pressure is applied to a surface of the detector and generating a signal that indicates the detected location.

10 Background of the Invention

 In a music and audio field, various devices having a point detecting sensor have been proposed to achieve an audio controller with good controllability. For example, a point detecting sensor for producing a DC output voltage
15 corresponding to a location of a pressure point has been proposed by Japanese Patent Laid-Open Publication No. 2000-267663 at pages 3-4 with reference to Figure 4. When the location of a pressure point is moved in a certain one-dimensional direction (X-direction), such a point detecting
20 sensor produces a DC output voltage indicative of the location of the pressure point,

 However, according to this conventional point detecting sensor, signals corresponding to the pressure points can be obtained only on a straight line, namely, on a one-
25 dimensional planar surface of the sensor. Hence, when obtaining the pressure point information of polar coordinates (r , θ) on a circular domain, a structure combined with both an X-axis sensor and a Y-axis sensor are required to create a rectangular sensor even when the information on either the
30 center angle θ or the absolute value r is sufficient.

 Further, the structure of the conventional point detecting sensor is complicated because it is necessary to conduct a process for polar conversion. In addition, even when the pressure point information of only the circular

domain is sufficient, the rectangular sensor having an X-axis sensor and a Y-axis sensor is required to encompass the circular domain. This results in design related limitations because of many useless parts such as the ones in the vertex areas of the rectangular sensor.

Summary of the Invention

Therefore, the present invention is proposed to solve such problems involved in the conventional technology, and it is an object of the present invention to provide a pressure point detector having a simple structure which is capable of detecting an area on a two dimensional surface such as a circular domain rather than on a straight line on which a pressure is applied.

In order to achieve the above object, the present invention is comprised of a flexible insulation member in a predetermined shape, a resistance film formed on one side of the flexible insulation member, a conductive member positioned to face the insulation member with a predetermined gap there between, and a pair of electrodes established on the resistance film having an insulation area between the electrodes to retrieve an output voltage from the conductive member.

In this pressure point detector, the insulation member and conductive member can be shaped like a disc. Further, the insulation member and conductive member can be formed by other shapes such as a semicircular shape or a triangular shape, etc.

Further, another embodiment of the present invention is comprised of a first flexible insulation member in a predetermined shape, a first resistance film formed on one side of the first insulation member, and a second insulation member in a predetermined shape, a second resistance film formed on one side of the second insulation member, wherein the first resistance film and the second resistance film are

placed to face each other with a predetermined gap therebetween, and a first pair of electrodes formed on the first resistance film having a first insulation area therebetween, and a second pair of electrodes formed on the second resistance film having a second insulation therebetween.

In the pressure point detector of the present invention, the first insulation member and the second insulation member are shaped like a disc, and the second pair of electrodes on the second resistance film is comprised of one electrode having a circular shape and formed at about a center of the second resistance film, and another electrode having a ring shape and formed around the outer edge of the second resistance film.

According to the present invention, the pressure point detector of a simple structure is achieved which is capable of detecting which location on a two dimensional surface such as a surface on a disc, rather than on a straight line, a pressure is applied can be achieved.

Brief Description of the Drawings

Figure 1 is a schematic diagram showing a plan view of the pressure point detector in the first embodiment of the present invention.

Figure 2 is a schematic diagram showing a side view of the pressure point detector in the first embodiment of the present invention.

Figure 3 is a schematic diagram showing voltage distribution for explaining an operation of the pressure point detector of the present invention.

Figure 4 is a schematic diagram showing a side view of the pressure point detector in the second embodiment of the present invention.

Figures 5A-5B are schematic diagrams showing structure of the pressure point detector in the second embodiment seen from a Y1-Y2 direction of Figure 4.

5 Figure 6 is a circuit diagram showing an electric structure including a switch unit for conducting the point detecting operation in the present invention.

Figures 7A-7B are schematic diagrams for explaining an operation of the pressure point detector in the modified versions of the present invention.

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Detailed Description of the Invention

The embodiments of the present invention will be explained below with reference to the accompanying drawings. Figure 1 is a plan view of the pressure point detector of the first embodiment in accordance with the present invention.
15 It should be noted that an insulation member 10 on the top surface of the pressure point detector is not shown in Figure 1 for the purpose of simplicity of explanation. Figure 2 is a side view of the pressure point detector of the present invention seen in the X-direction of Figure 1.
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As seen from Figures 1 and 2, the pressure point detector is formed of an insulation member 10 made of insulation material, a resistance film 15 made of material having electric resistance such as carbon which is formed on the entire bottom surface of the insulation member 10, a pair of flat and long shaped electrodes 3a and 3b established in parallel between the resistance film 15 and the insulation member 10, and a conductive member 20 made of conductive material formed on the insulation member 10 with a small distance or a gap from the resistance film 15.
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In this example, each of the insulation member 10 and the resistance film 15 has a flat disc shape. Each of the electrodes 3a and 3b is connected with the resistance film 15. A long and flat slit 17 is formed between the electrodes 3a and 3b in an up-down direction of Figure 1 as an
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insulation area to secure an insulating state between the two electrodes 3a and 3b. A predetermined voltage (V_{in}) is supplied to the pressure point detector between the electrode 3a and the electrode 3b from a power source 1 through electric wires 4a and 4b.

The conductive member 10 is a very thin disc-shaped flat layer having a slightly smaller diameter than that of the disc shaped insulation member 10. In order to maintain the gap between the insulation member 10 while allowing the insulation member 10 to be pressed by a user, for example, small and very thin elastic support members (not shown) will be provided between the insulation member 10 and the conductive member 20 at locations not within the area subject to the pressure.

An output terminal 2 for outputting the voltage from the pressure point detector is connected to the conductive member 20. Thus, when a pressure PS is applied to the insulation member 10 as shown in Figure 2, the part of the resistance film 15 corresponding to the pressure point P comes in contact with the conductive member 20 so that the voltage indicative of the location of the pressure point P is generated from the output terminal 2.

The operation of the pressure point detector of the present invention is explained with reference to Figure 3. When the voltage V_{in} from the power source 1 is supplied between the electrodes 3a and 3b where the electrode 3a is connected to the ground, the resistance film 15 forms a predetermined pattern of voltage distribution. In the example of Figures 1 and 2, the voltage distribution can be expressed by equipotential lines each being extended in a radial direction from the center of the disc-shaped resistance film 15. In this example, the amount of voltage on the equipotential line is the smallest near the electrode 3a with the ground voltage 0(V) and is the largest near the electrode 3b with the source voltage V_{in} (V). In other words,

in Figure 3, the electric potential distribution is formed in such a way that the voltages showing the equipotential lines are larger in a clockwise direction.

Thus, as shown in Figure 3, the voltage on the
5 resistance film 15 changes in response to the position on the
insulation member 10 in a circular direction θ starting from
the position of 0V on the equipotential line. In Figure 3,
the changes from 0V to V_{in} out of the multiple equipotential
lines are listed per $0.1V_{in}$. Thus, when a certain point on
10 the insulation member 10 is pressed, the voltage on the
resistance film 15 corresponding to the pressure point on the
insulation member 10 is transmitted to the conductive member
20 and is generated from the output terminal 2. In other
words, Figure 3 shows the relationship between the pressure
15 points on the insulation member 10 and the output voltages
representative of the locations of the pressure point.

Hence, the pressure point detector of the present
invention is capable of detecting which locations on the two-
dimensional surface such as on a curved line of the pressure
20 points rather than on a straight line are pressed. The
pressure point detector has a simple structure which includes
the flexible disc shaped insulation member 10 on which the
resistance film 15 is formed at one side, and the conductive
member 20 positioned to face the resistance film 15 on the
25 insulation member 10 with a predetermined gap therebetween.
The slit 17 (insulation area) as well as the pair of
electrodes 3a and 3b are established in a parallel fashion
on the resistance film 15 as noted above so that the output
voltage from the conductive material 20 can be obtained
30 through the output terminal 20.

In the foregoing description of the pressure point
detector of the present invention, the resistance film 15 and
the insulation member 10 are in a flat circular shape.
However, as shown in Figures 7A and 7B, the resistance film
35 15 and the insulation member 10 can be various other shapes,

such as a flat semi-circular shape or a flat fan shape, as well as a flat elliptical shape. Since the equipotential lines are formed radially from the center of the resistance film regardless of the shape of the insulation member and the resistance film, the pressure points on the insulation member can be detected in a circular direction. The present invention can also be applied even if the resistance film 15 is, for example, structured three-dimensionally such as a cone shape or a ball shape.

Since the detection voltage corresponding to the location of the pressure point in the circular direction can be obtained as described above, the pressure point detector of the present invention can be used as a musical performing device for various toys and music instruments. For example, eight sounds of "do-re-mi-fa-so-la-ti-do" are divided into eight areas (locations) on the insulation member 10 so that the corresponding audio sounds can be generated in response to the location which is subject to the pressure operation. This is only one example of many possible applications of the pressure detector of the present invention.

Figure 4 is a side view of the second embodiment of the pressure point detector in accordance with the present invention. Figure 5A is a diagram showing a bottom view of a resistance film 150 of the pressure point detector as seen in the direction of the arrow Y1 in Figure 4, and Figure 5B is a diagram showing a top view of a resistance film 151 of the pressure point detector as seen in the direction of the arrow Y2 in Figure 4.

As shown in Figures 4 and 5B, the resistance film 151 is formed on a top surface of a thin disc-shaped insulation member 101 made of insulation material. In addition, a flat circle shaped electrode 131a is formed on the surface of the resistance film 151 at the center thereof, and a flat ring-shaped electrode 131b is formed on the surface of the resistance film 151 around an outer edge thereof. In other

words, the electrode 131a is a small disc like electrode at the center of the resistance film 151 and the electrode 131b is a large ring like electrode at the edge of the resistance film 151. As shown in Figure 4, electric wires 141a and 141b are connected to the electrodes 131a and 131b, respectively. It should be noted that the electrical wires 141a and 141b are not shown in the bottom view of Figure 5B for simplicity of illustration.

As shown in Figures 4 and 5A, the resistance film 150 is formed on a bottom surface of a thin disc-shaped insulation member 100 made of insulation material. In addition, a pair of flat line-shaped electrodes 130a and 130b are formed in a parallel fashion on the surface of the resistance film 150 in a right-left direction on the top view of Figure 5A. The electrodes 130a and 130b are not shown in the side view of Figure 4 for simplicity of illustration. A long slit 160 is formed between the parallel electrodes 130a and 130b from the center of the resistance film 150 as an insulation area. In Figure 4, electric wires 140a and 140b are connected to the electrodes 130a and 130b, respectively. It should be noted that the electrical wires 140a and 140b are not shown in the top view of Figure 5A for simplicity of illustration.

As shown in Figure 4, the resistance films 150 and 151 are positioned to face each other with a gap therebetween in a manner that the electrodes noted above do not touch the resistance films or other electrodes when no pressure is applied to the pressure point detector. In order to maintain such a gap while allowing the insulation member 100 to be pressed by a user, very thin and small elastic members can be used between the resistance film 150 and the resistance film 151 at locations other than the areas which are used to receive the pressure by the user.

Figure 6 is a circuit diagram showing an electrical structure of the control system in the pressure point

detector of the present invention. A switch unit 300 in the circuit diagram can change the circuit connection between a first mode and a second mode. In the first mode, the switch unit 300 connects terminals E1 and A1, terminals E2 and A2, terminals E3 and C1, and terminals E4 and C2 at the same time. In the second mode, the switch unit 300 connects the terminals E1 and B1, terminals E2 and B2, terminals E3 and D1, and terminals E4 and D2 at the same time.

In the first mode, a voltage V_{in} from a power source 200 is supplied to the electrodes 130a and 130b through the electric wires 140a and 140b, and the output corresponding to the pressure points in the circular direction on the insulation member 100 can be obtained from the terminals C1 and C2. On the other hand, in the second mode, the voltage V_{in} from the power source 200 is supplied to the electrodes 131a and 131b through the electric wires 141a and 141b, and the output corresponding to the pressure points in a radial direction (the distance from the center) on the insulation member 101 can be obtained from the terminals B1 and B2.

The operation of the pressure point detector in the second embodiment of the present invention will be explained in the following. First, when the switch unit 300 switches the circuit connection of Figure 6 to the first mode, the terminals E1 and A1, terminals E2 and A2, terminals E3 and C1, and terminals E4 and C2, respectively, are connected at the same time. As a result, the voltage V_{in} from the power source 200 is supplied to the electrodes 130a and 130b through the wires 140a and 140b.

Consequently, the electric potential distribution on the resistance film 150 described with reference to Figure 3 is established, and the voltage on the resistance film 150 corresponding to the pressure points P, namely, the output voltages corresponding to the locations of the pressure point in the circular direction can be obtained. This is because the resistance film 150 and the resistance film 151 become

conductive, and the voltage corresponding to the pressure point of the resistance film 150 can be obtained from the terminals C1 and C2.

5 On the other hand, when the switch unit 300 sets the circuit connection to the second mode, the terminals E1 and B1, terminals E2 and B2, terminals E3 and D1, and terminals E4 and D2, respectively, are connected at the same time. As a result, the voltage V_{in} from the power source 200 is supplied to the electrodes 131a and 131b through the electric
10 wires 141a and 141b.

Consequently, the equipotential lines on the resistance film 151 are formed in concentric circles, which in this case, has a higher electric potential as it gets closer to the center of the pressure point detector. In other words,
15 the voltage is 0V on the concentric circle close to the electrode 131b and $V_{in}(V)$ on the concentric circle close to the electrode 131a. Thus, the voltage between electrodes 131a and 131b gradually changes when the position in the radial direction changes.

20 Therefore, the voltage of the resistance film 151 corresponding to the pressure point P, namely, the output corresponding to the location of the pressure point in the radial direction can be obtained from the terminals B1 and B2. This is because the resistance film 150 and the
25 resistance film 151 become conductive by the pressure, and the voltage corresponding to the pressure point of the resistance film 151 can be obtained from the terminals B1 and B2. When the end of the electrode 131a or 131b is pressed, the electrodes 130a and 130b may be connected with one
30 another through either the electrode 131a or 131b. However, such an unwanted contact between the electrodes can be avoided by incorporating an insulation film (not shown) on the surface of the electrodes, and thus, the electrodes will not electrically contact with one another.

Therefore, according to the second embodiment of the present invention, signals corresponding to the locations of the pressure points in the radial direction or in the circular direction can be obtained by comprising the flexible
5 disc-shaped (or other predetermined shape) insulation member 100 (first insulation member) having the resistance film 150 on one surface thereof, and a disc-shaped (or other predetermined shape) insulation member 101 (second insulation member) having the resistance film 151 on one surface, where
10 both of the resistance films 150 and 151 are positioned to face each other, and where the slit 160 is established as an insulation area between the pair of electrodes 130a and 130b on the resistance film 150, and the pair of electrodes 131a and 131b are established on the resistance film 151 on the
15 insulation member 101.

The embodiments of the present invention have been explained above with respect to the specific structure, however, various changes and modifications can be possible on these embodiments within the basic concept of the present
20 invention. For example, the structure of the switch unit 300 shown in Figure 6 can be modified depending on a particular configuration of the pressure point detector, and an amplifier can be incorporated to amplify the voltage signals by connecting to the terminals for obtaining amplified
25 signals. Further, in the first embodiment described above, the shape of the conductive member 20 is matched with the shape of the insulation member 10, however, the conductive member 20 can have various other shapes.

Moreover, in the second embodiment, the shape of the
30 resistance film 151 (or insulation member 101) is matched with the shape of the insulation member 100, however, so long as an overall area of one resistance film is covered by an area of the other resistance film, each resistance film (or insulation member) does not have to have the same shape with
35 one another. Also, in Figure 4, it has been explained that

the surface of insulation member 100 is subject to the pressure operation, however, it is also possible that the surface of the insulation member 101 could be subject to the pressure operation as well.

5 As has been explained above, according to the present invention, the pressure point detector of a simple structure is achieved which is capable of detecting which location on a two dimensional surface such as a surface on a disc, rather than only a straight line, a pressure is applied can be
10 achieved.